

Fluorescence Color Instrumentation and Standards

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Why is fluorescence important in color applications?

- ⇒ Enhances the apparent brightness of objects
- ⇒ Increases conspicuity (safety aspects)
- ⇒ makes objects more esthetically pleasing by eliminating or disguising 'yellowness' or 'greyness' associated with unclean objects



Fluorescence Colorimetry

Why a fluorescence colorimeter?

- ⇒ Conventional colorimeters or color spectrophotometers cannot accurately measure the fluorescent component of color
- ⇒ To aid in the formulation and quality control of materials and coatings with fluorescent additives.



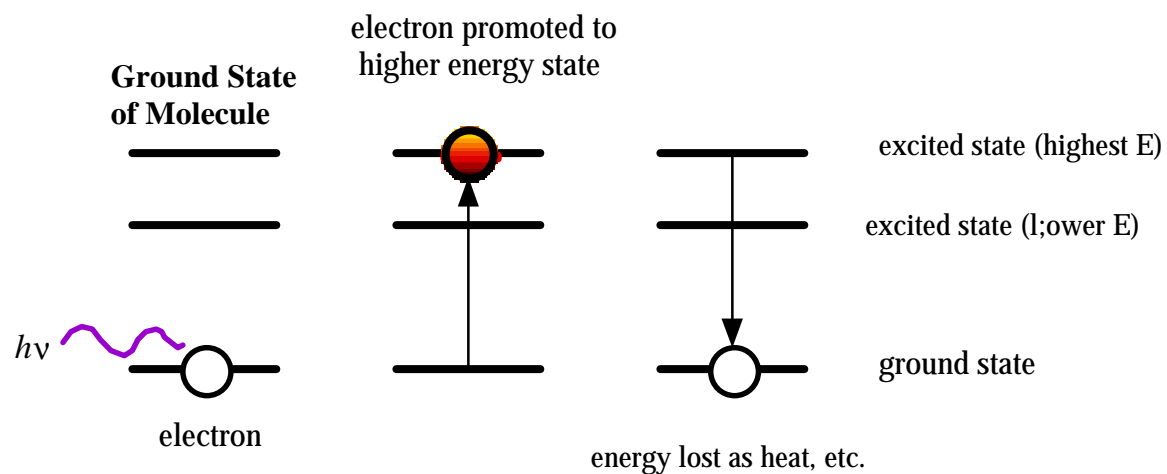
Fluorescence Colorimetry

What is fluorescence or phosphorescence?

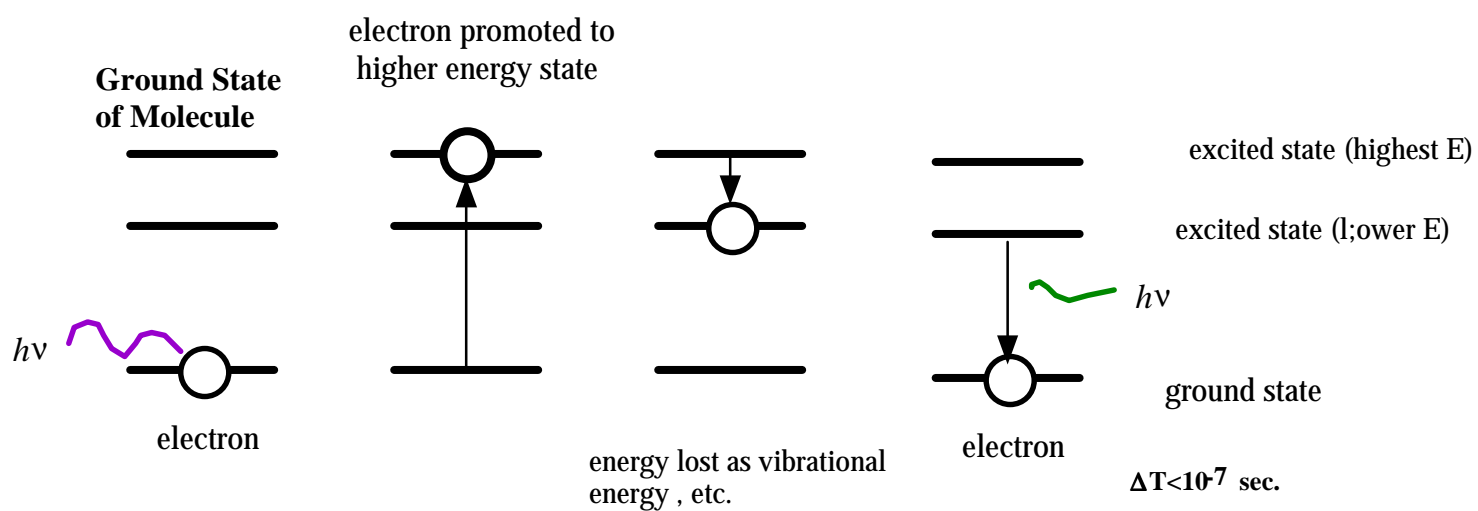
⇒ Simply the property of certain materials to absorb radiation at one wavelength then re-emit that radiation at another, usually longer, wavelength



Absorbance/Reflectance



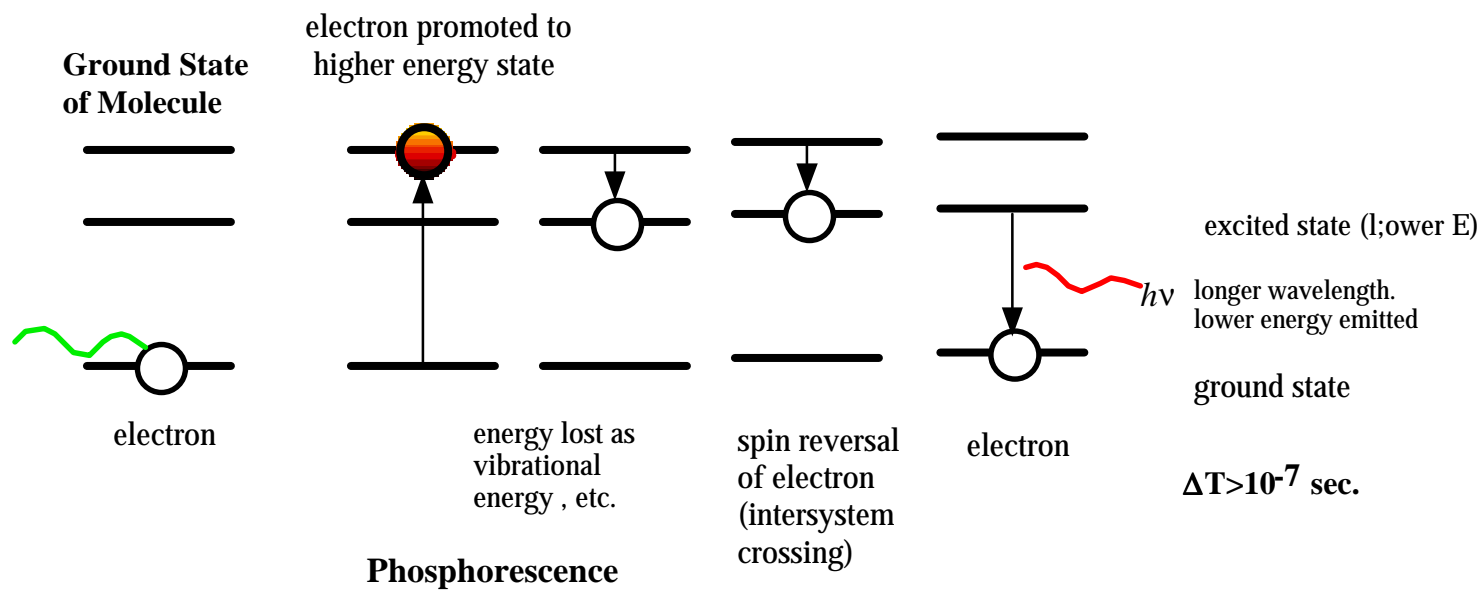
Fluorescence



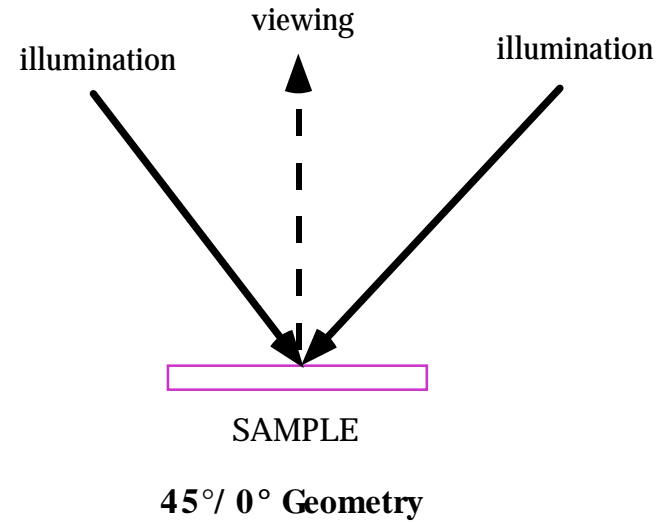
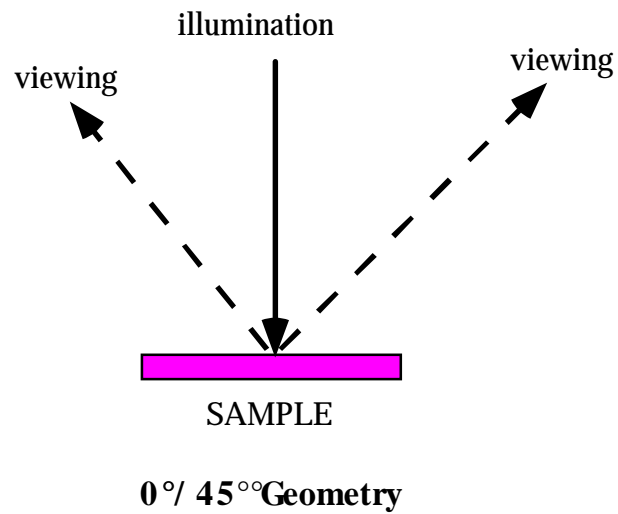
Fluorescence



Phosphorescence



0/45 and 45/0 Geometries



Monochromatic or polychromatic illumination

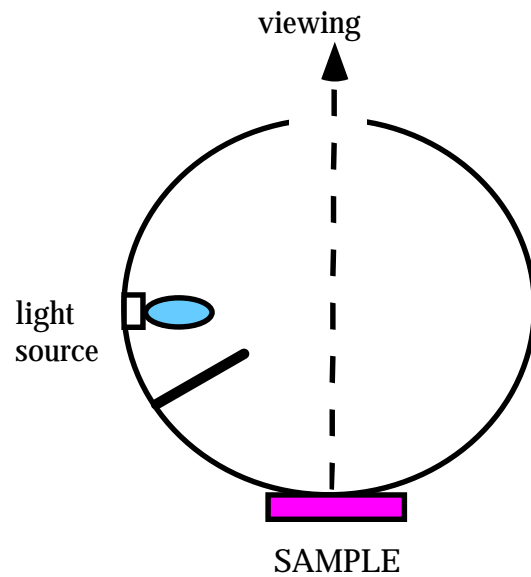


Directional-Directional Geometry

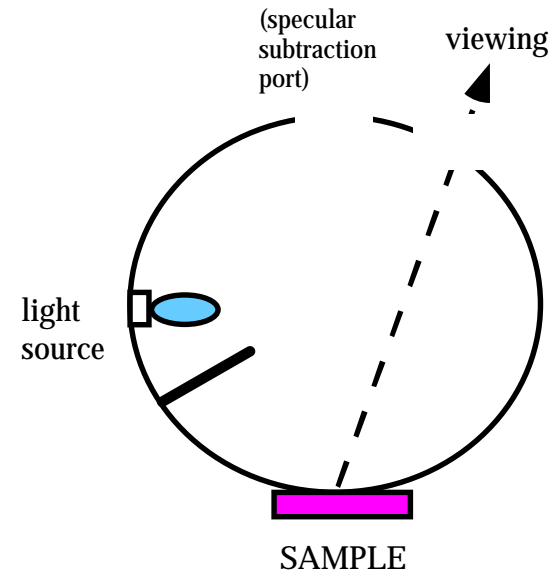
- ⇒ Typically 45/0 or 0/45
- ⇒ Directionally sensitive to structured samples such as textiles
- ⇒ No possibility of sphere re-radiation errors
- ⇒ “Referee method” of National Laboratories such as NRC, BAM, and NPL
- ⇒ May be used in bispectral mode



d/0° and d/8° Geometries



**Diffuse/ 0° sphere geometry
(specular component removed)**



**Diffuse/ 8° sphere geometry
(specular component included)**

Polychromatic illumination



Hemispherical Geometry

- ⇒ $d/0^\circ$ or $d/8^\circ$ typically used for fluorescent materials.
- ⇒ Not directionally sensitive to structured samples such as textiles. Consequently typical method used in paper and textile industry
- ⇒ Possibility of sphere re-radiation errors
- ⇒ Typical reflectance geometry of $8^\circ/d$ is not useable for fluorescent materials.
- ⇒ May be used in bispectral mode but...



Sphere Re-Radiance Error

- ⇒ When the emission and excitation spectra from a fluorescent species overlap, there is the potential for sphere re-radiance error.
- ⇒ The question becomes, is the source of the emission from the source, or a combination of the source and the re-emitted radiation from the sample?
- ⇒ The error is small but real...



Sphere Re-Radiance Error

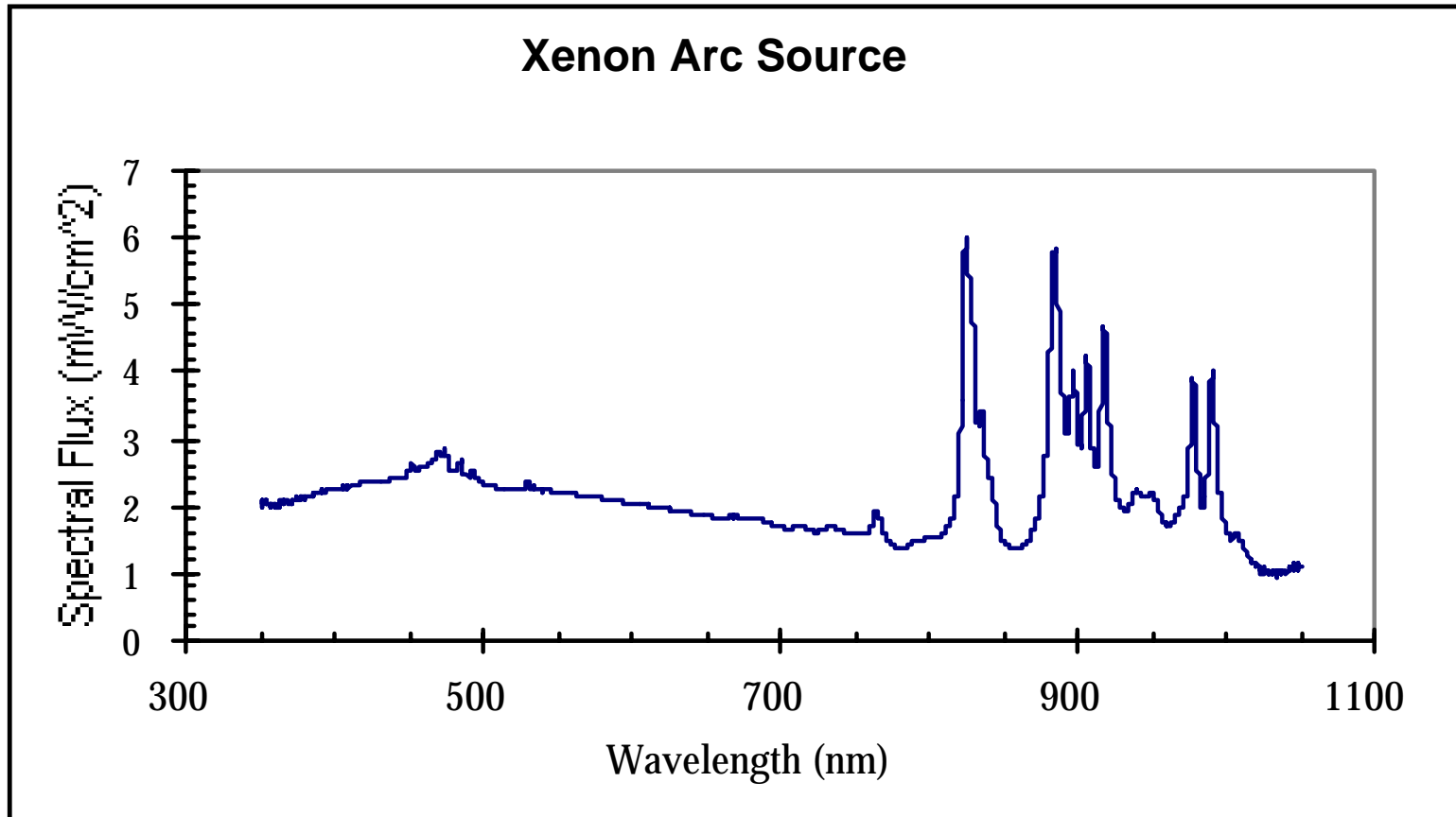


Illuminants

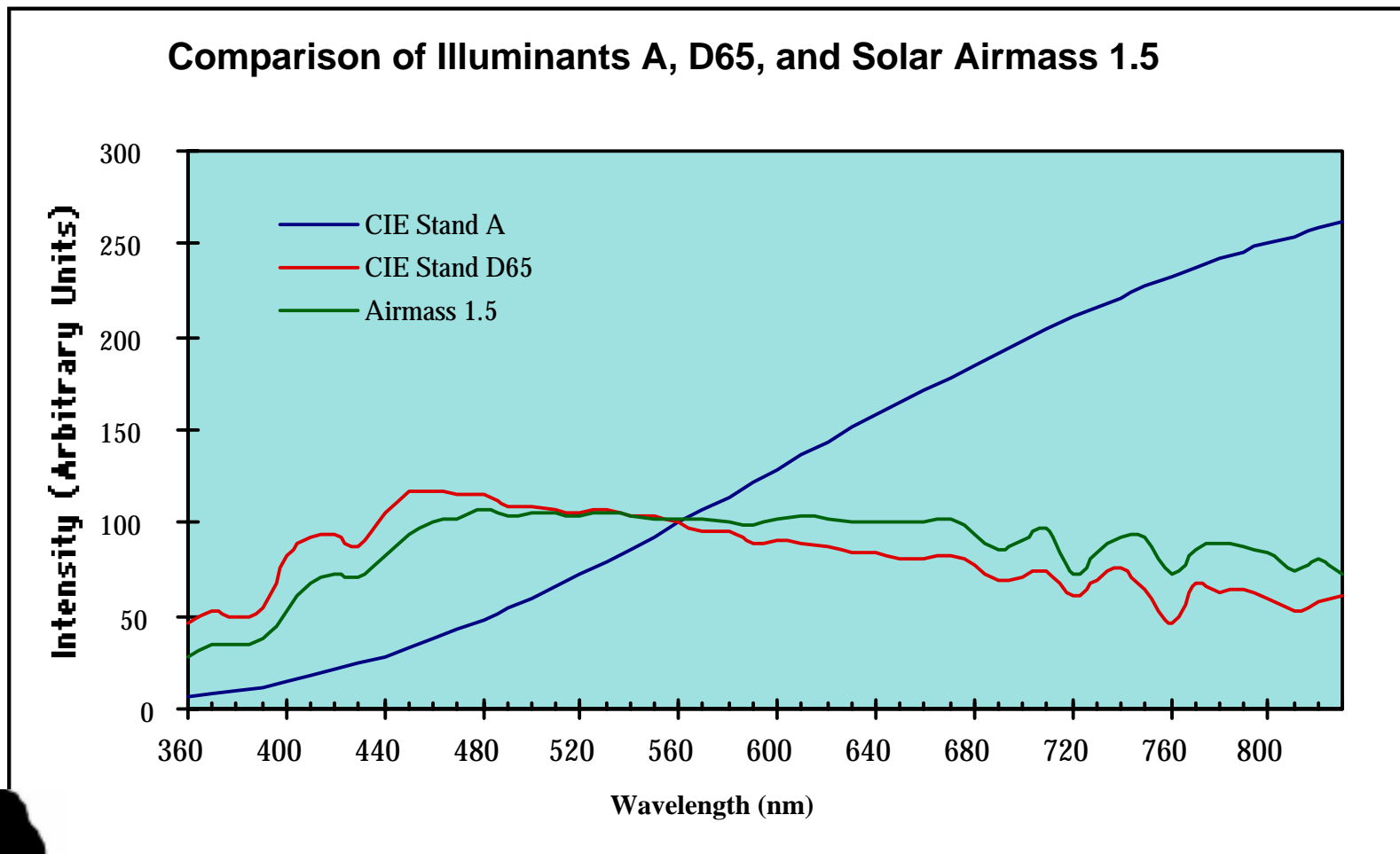
- ⇒ Change in illuminant can and does lead to change in appearance.
- ⇒ Especially problematical for luminescent materials
- ⇒ Typical 'standard illuminant is not typical of the way materials are usually encountered
- ⇒ Monochromatic illumination is ideal but...
- ⇒ Cannot use in standard geometry used for most reflectance or color measurements
- ⇒ “Bispectral” geometry needed.



Typical Sources for Measuring Fluorescent Color

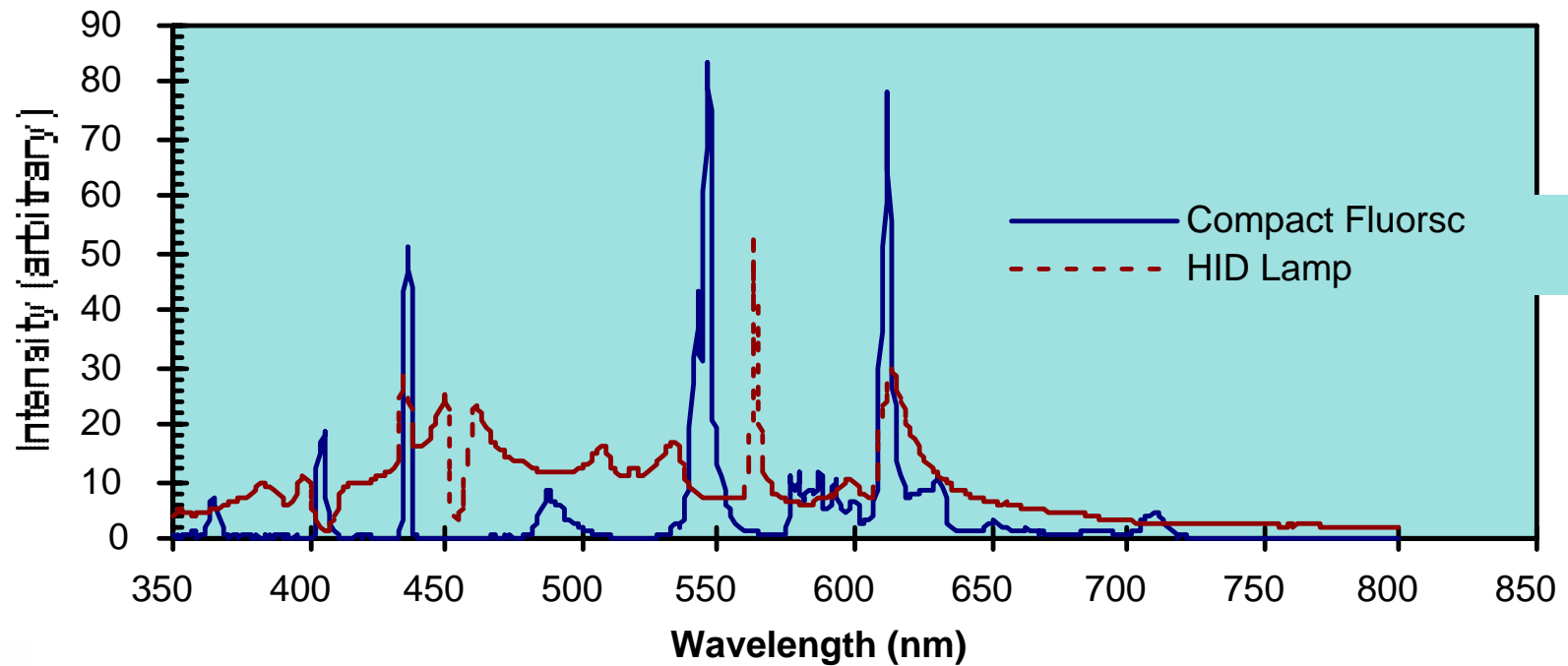


Typical Sources for Measuring Fluorescent Color



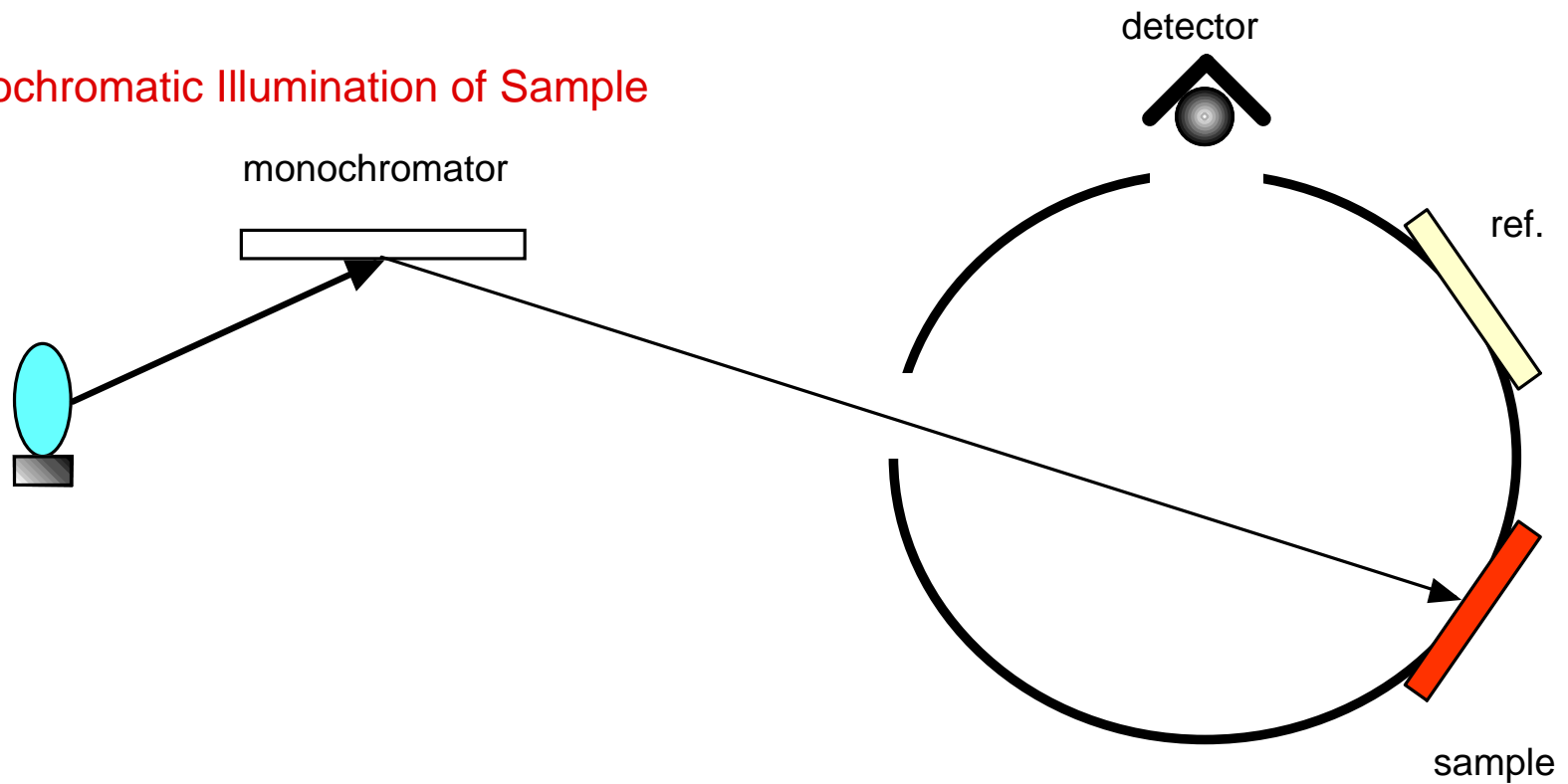
Typical Sources for Viewing Fluorescent Color

**Compact Fluorescent/HID lamp
Illuminants**

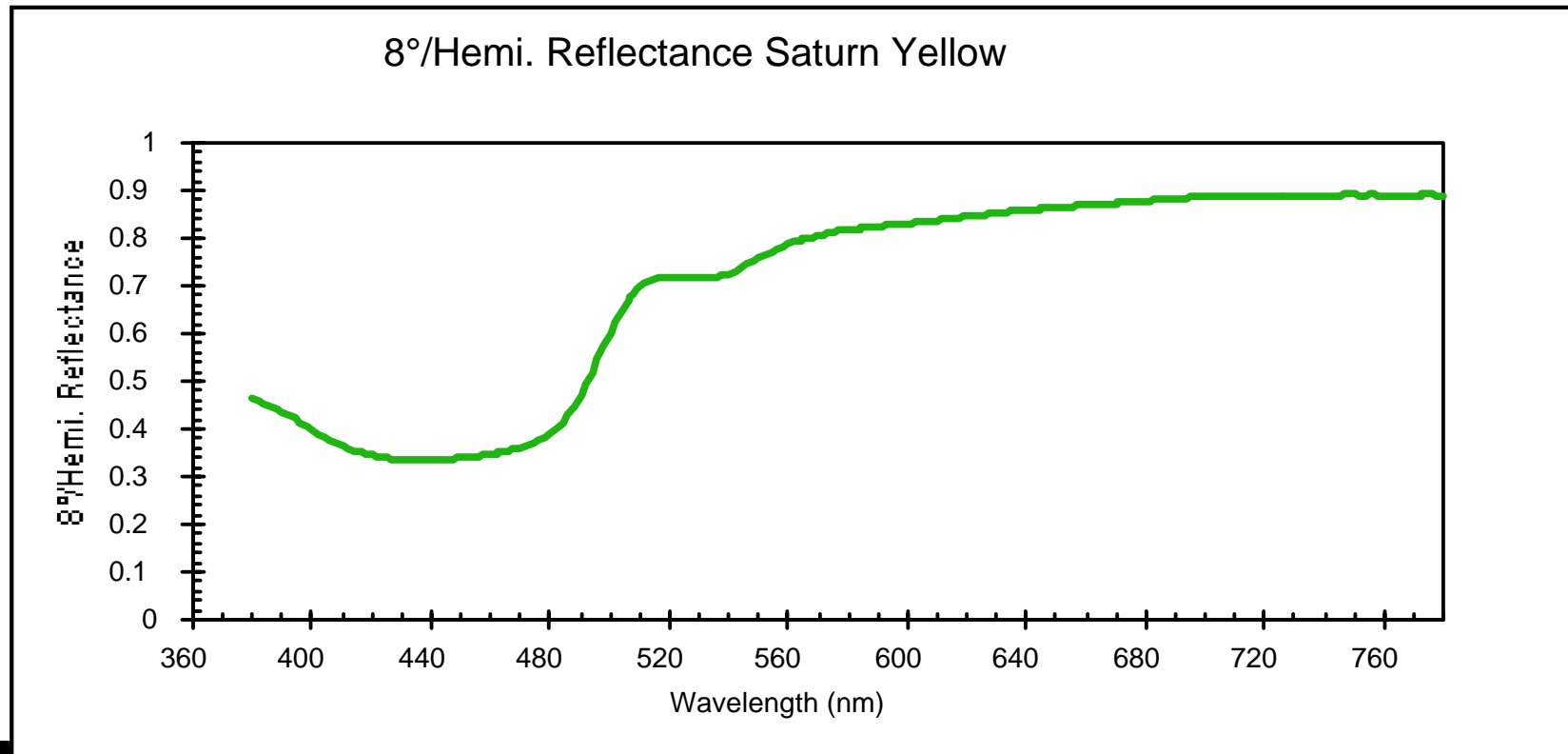


Monochromatic Illumination Polychromatic Detection

Monochromatic Illumination of Sample

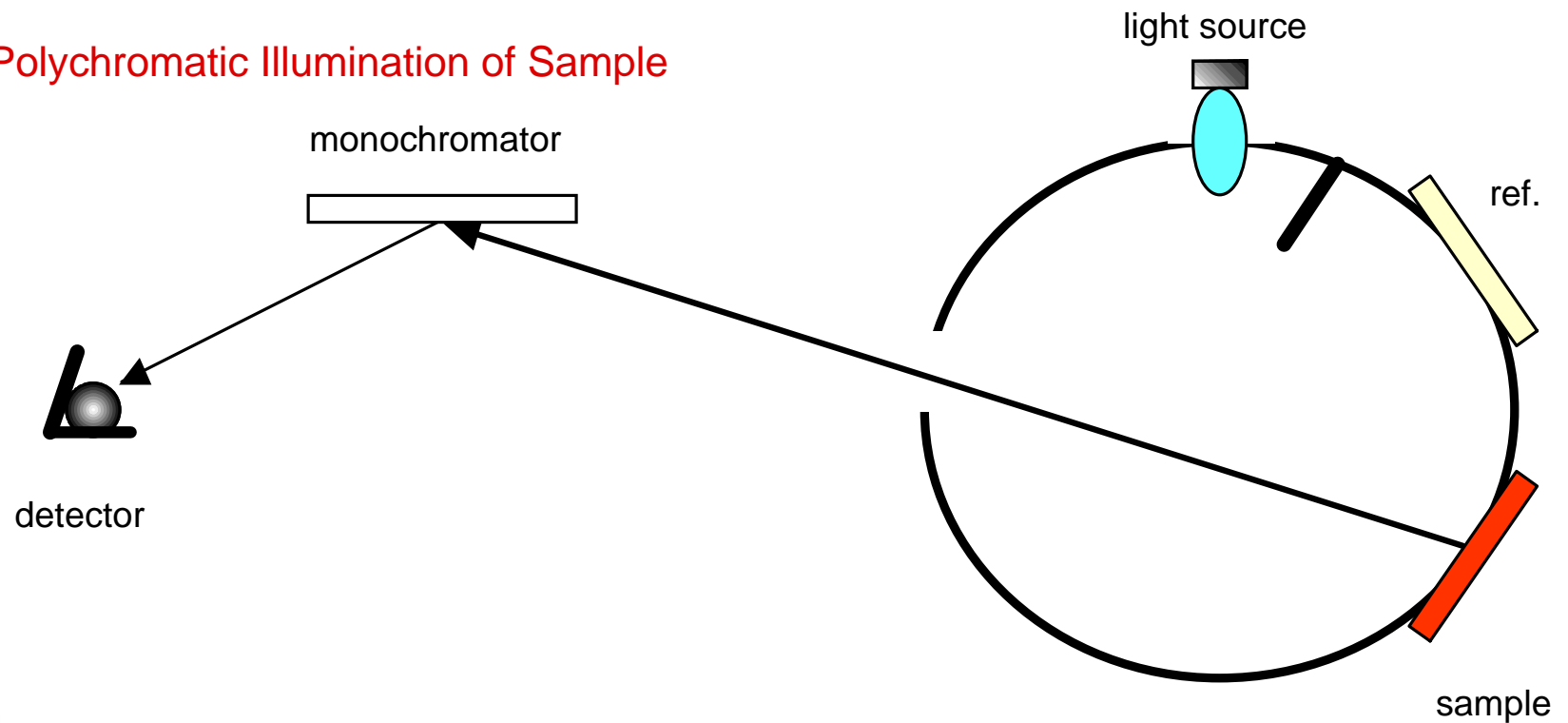


Monochromatic Illumination/ Polychromatic Detection

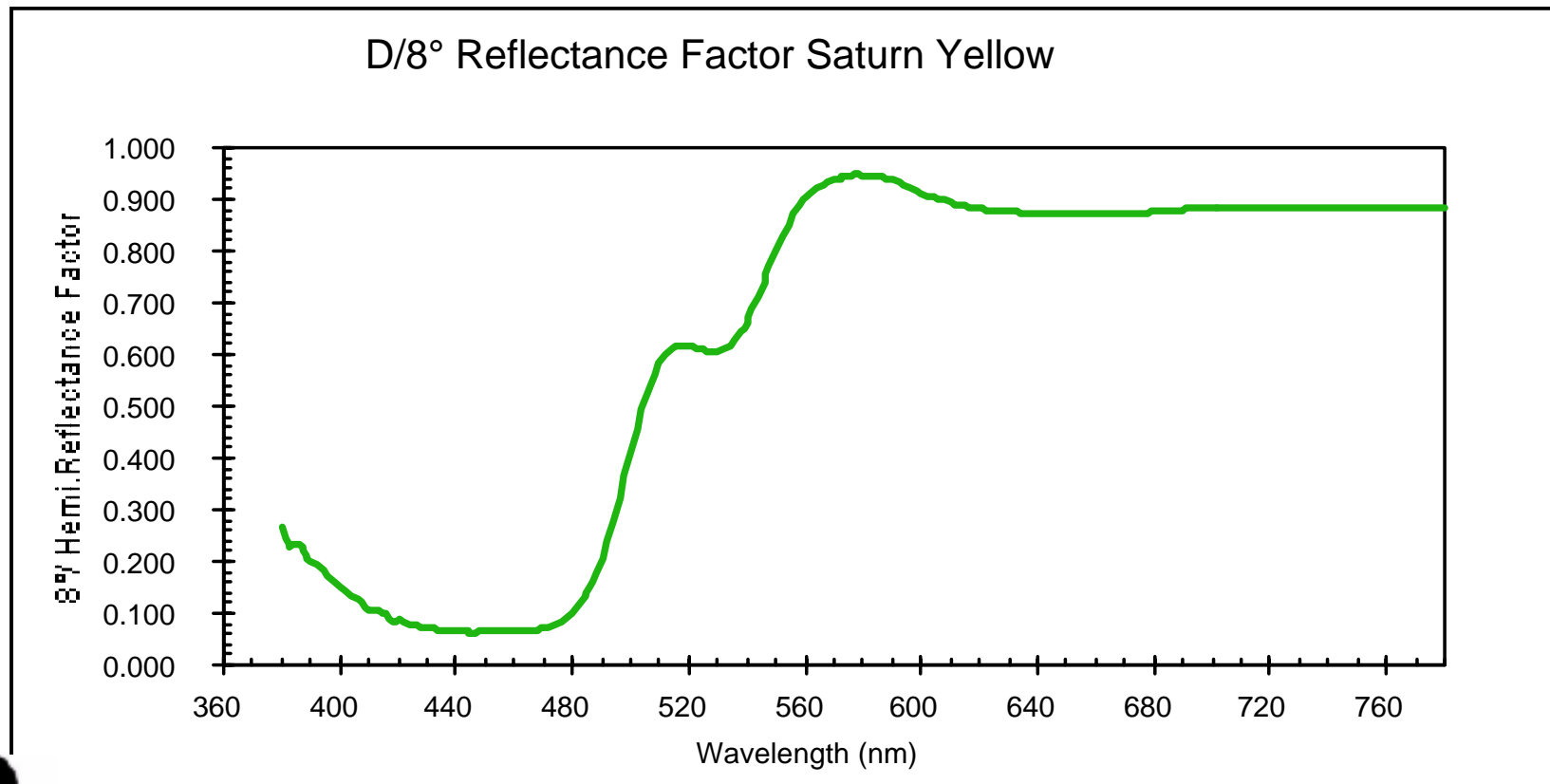


Polychromatic Illumination Monochromatic Collection

Polychromatic Illumination of Sample



Polychromatic Illumination/Monochromatic Detection



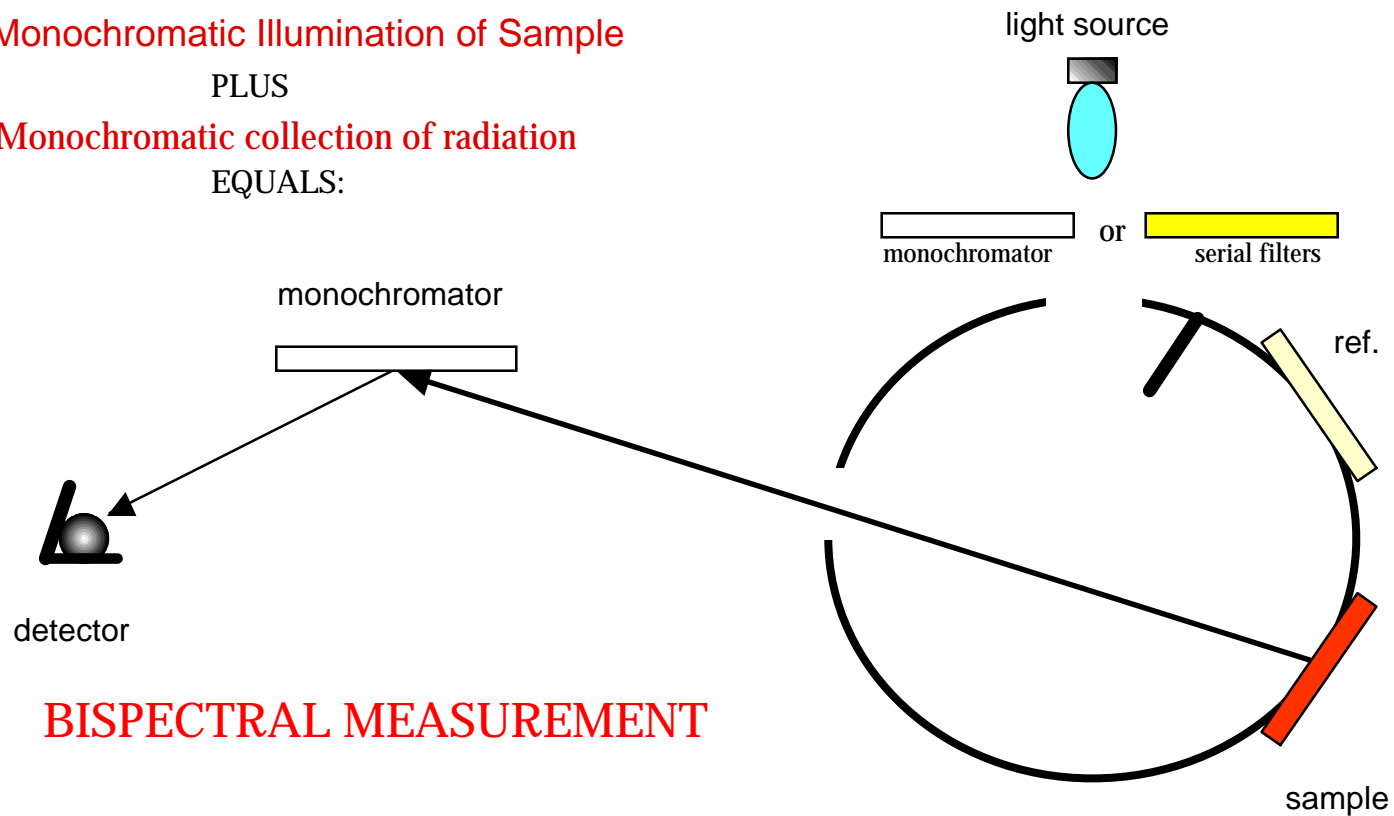
BiSpectral Geometry

Monochromatic Illumination of Sample

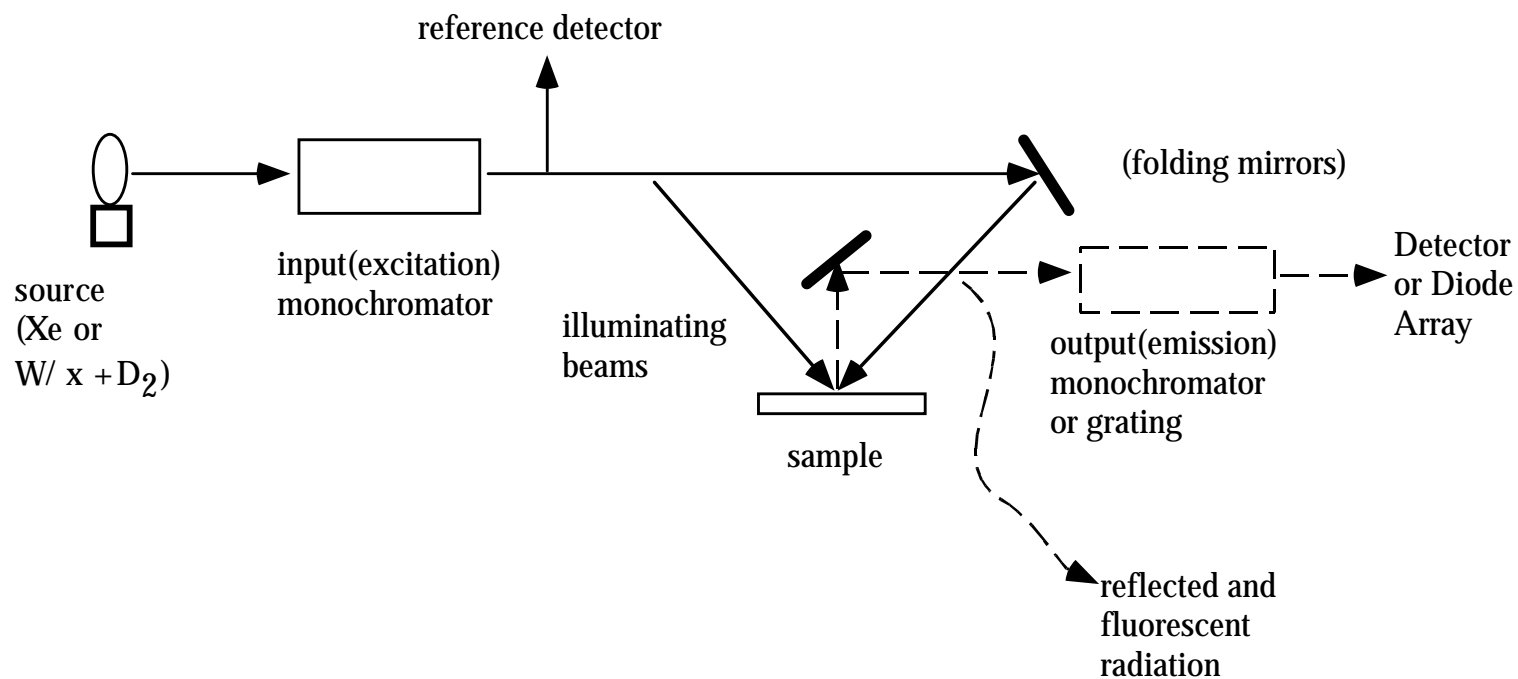
PLUS

Monochromatic collection of radiation

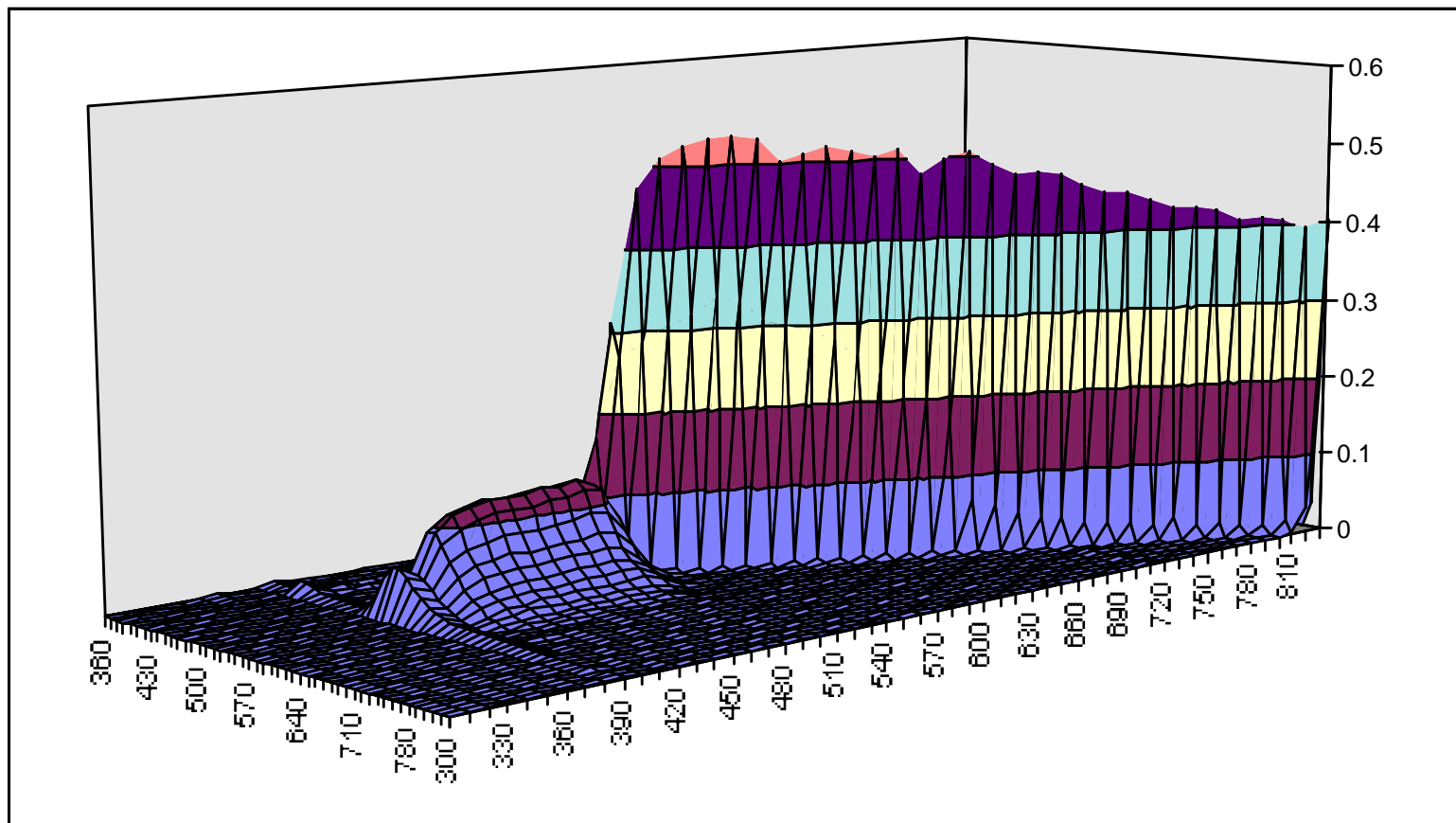
EQUALS:



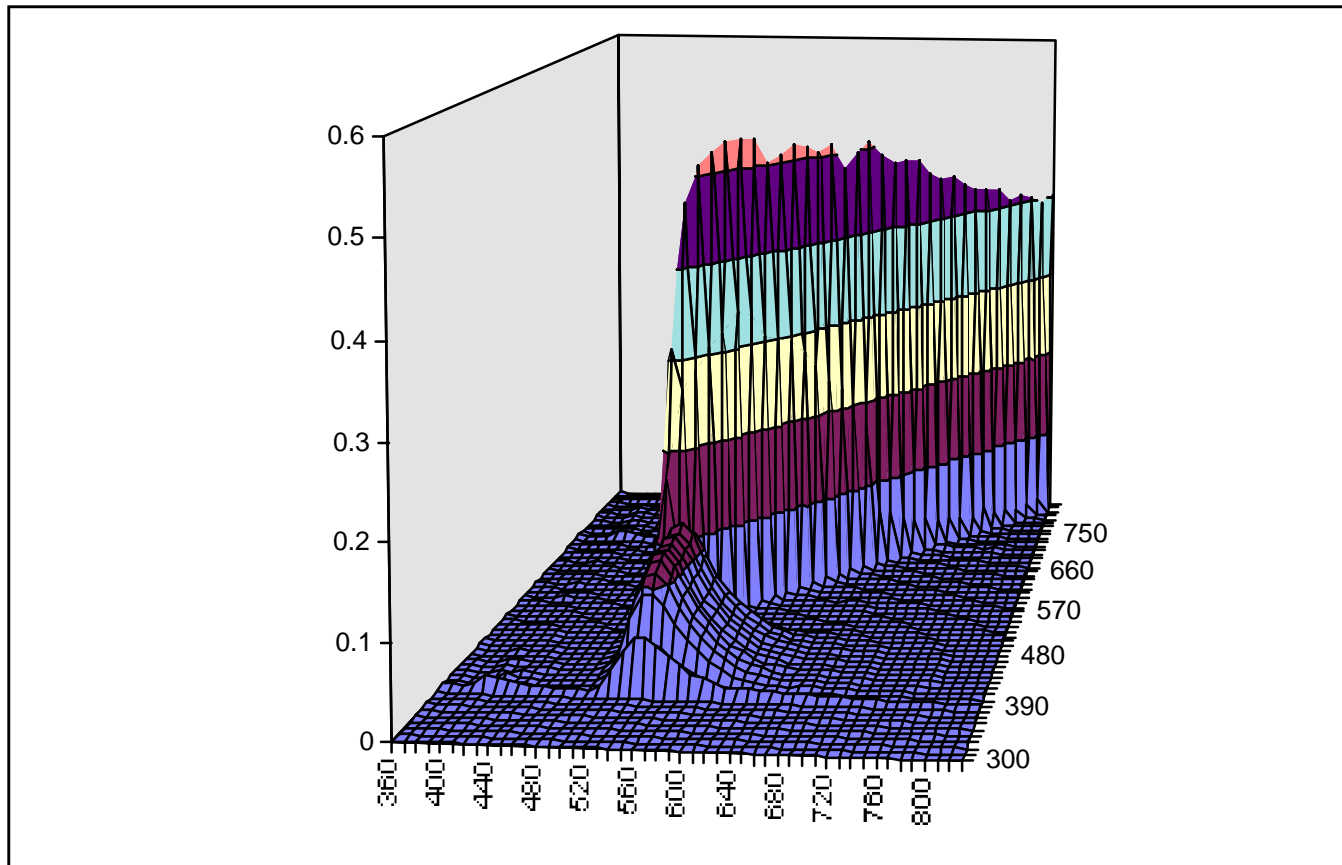
Bispectral Instrument Geometry



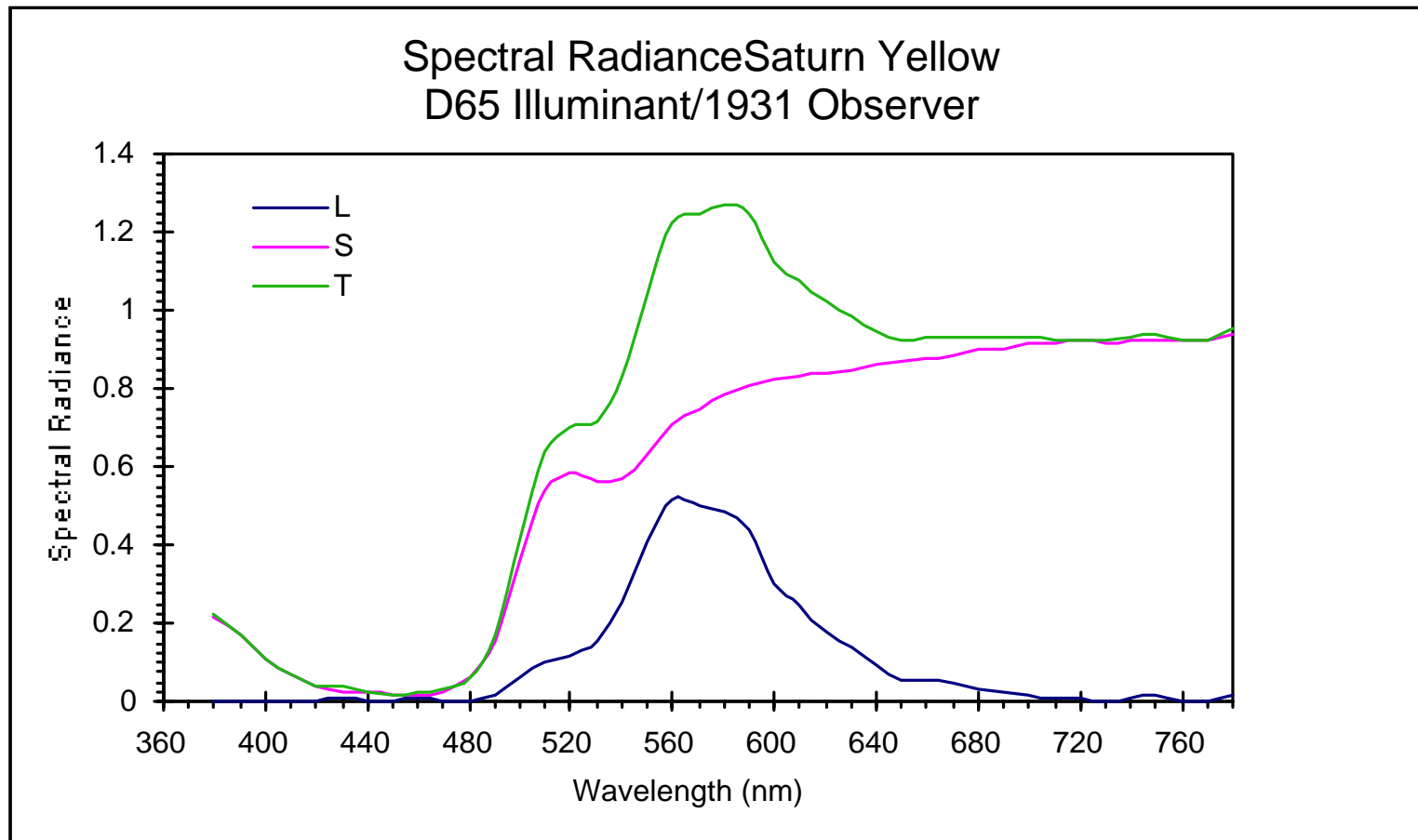
Bispectral Matrix- View 1



Bispectral Matrix- View 2



Bispectral Radiance Measurement



Fluorescent Color Standards

Availability and Potential Pitfalls

- ⇒ Not as readily available as standards of reflectance
- ⇒ Few laboratories calibrate them
- ⇒ Question of what geometry to use
- ⇒ Question on what materials to use due to questions of long term stability
- ⇒ Need different standards for different applications



Fluorescent Color Standards

National Laboratories with ability to calibrate and geometry used

- ⇒ **NPL**- 0/45, bispectral (Dr. Peter Clarke)
- ⇒ **NRC**- 0/45, bispectral (Dr. Joanne Zwinkels)
D/0° (ISO Brightness, paper)
- ⇒ **BAM**- 0/45, D65 illuminant (Dr. Klaus Witt)
- ⇒ **NIST**- In design and construction
(Dr. Maria Nadal and Ted Early)



Fluorescent Color Standards

Available Standards-1

(aimed at Paper/Textile Industry)

- ⇒ FTS Plastic White Standards (F.T. Simon)*
- ⇒ Höhenstein Plastic Standards**
- ⇒ Avian Technology Plastic Standards (Avian Technologies)
- ⇒ STFi Paper Standards (STFi- Sweden)
- ⇒ Labsphere SFS-461 and SFS-205 (Labsphere, Inc.)

*FTS provides blanks for a number of manufacturers

**provided by Avian Technologies, formerly by Ciba-Geigy



Fluorescent Color Standards

Available Standards-2

Chromatic Standards-Daylight Fluorescents

- ⇒ **NPL (yellow, orange , 'red')- “daylight fluorescents” based on 3M® technology**
- ⇒ **FTS (yellow, orange, red)- “daylight fluorescents” based on Day-Glo® Technology**
- ⇒ **Labsphere SFS materials (red, orange, green); UV activated, fluorocarbon based.**



Fluorescent Color Standards

Available Standards-3

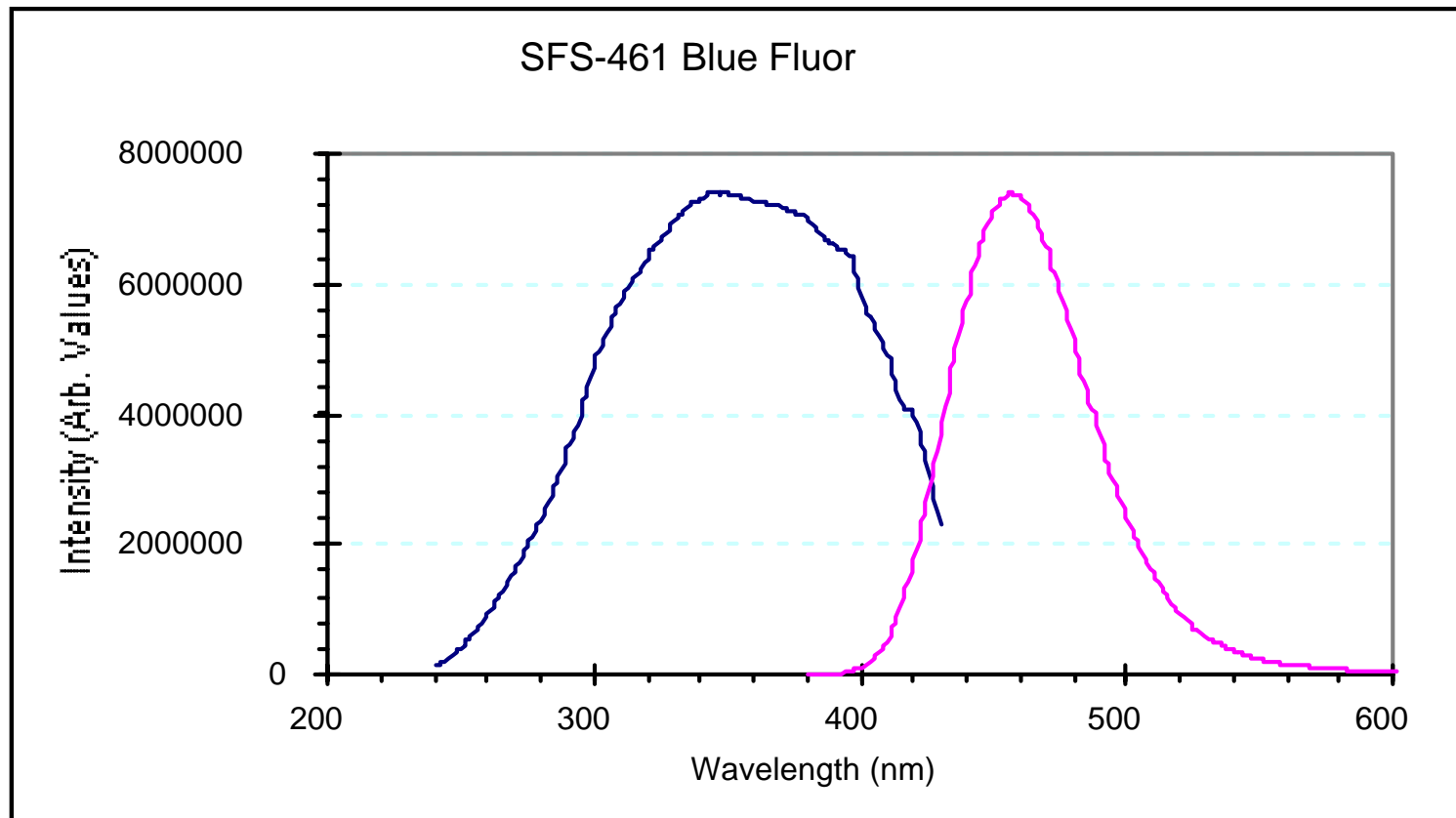
Chromatic Standards-UV-Activated Fluorescents

- ⇒ **Labsphere SFS materials (red, orange, green); UV activated, fluorocarbon based.**
- ⇒ **Matech Fluors (red, green, blue); UV-activated, glass based.**



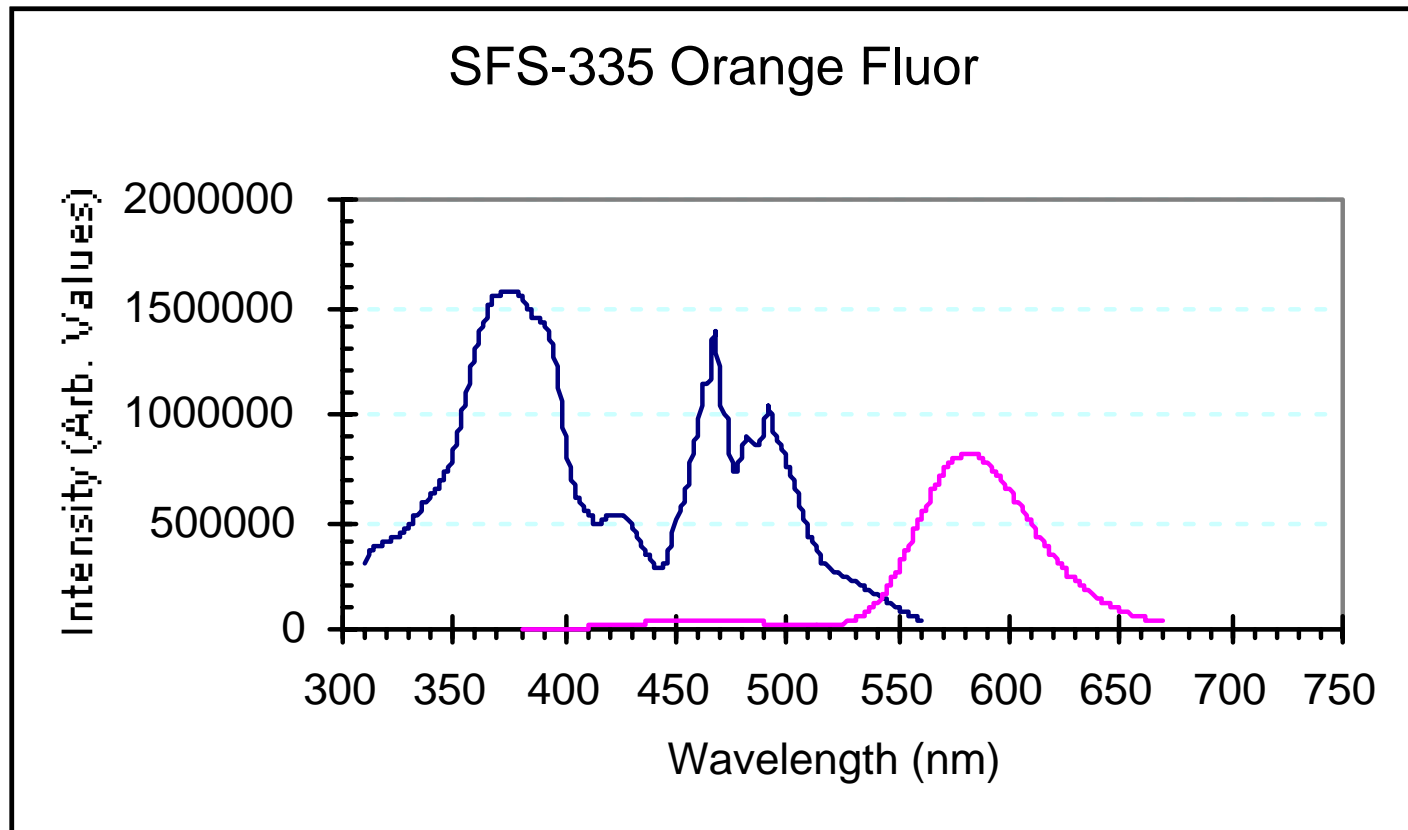
Examples of Spectralon Luminescent Standards

Blue-White Luminescent Pigment

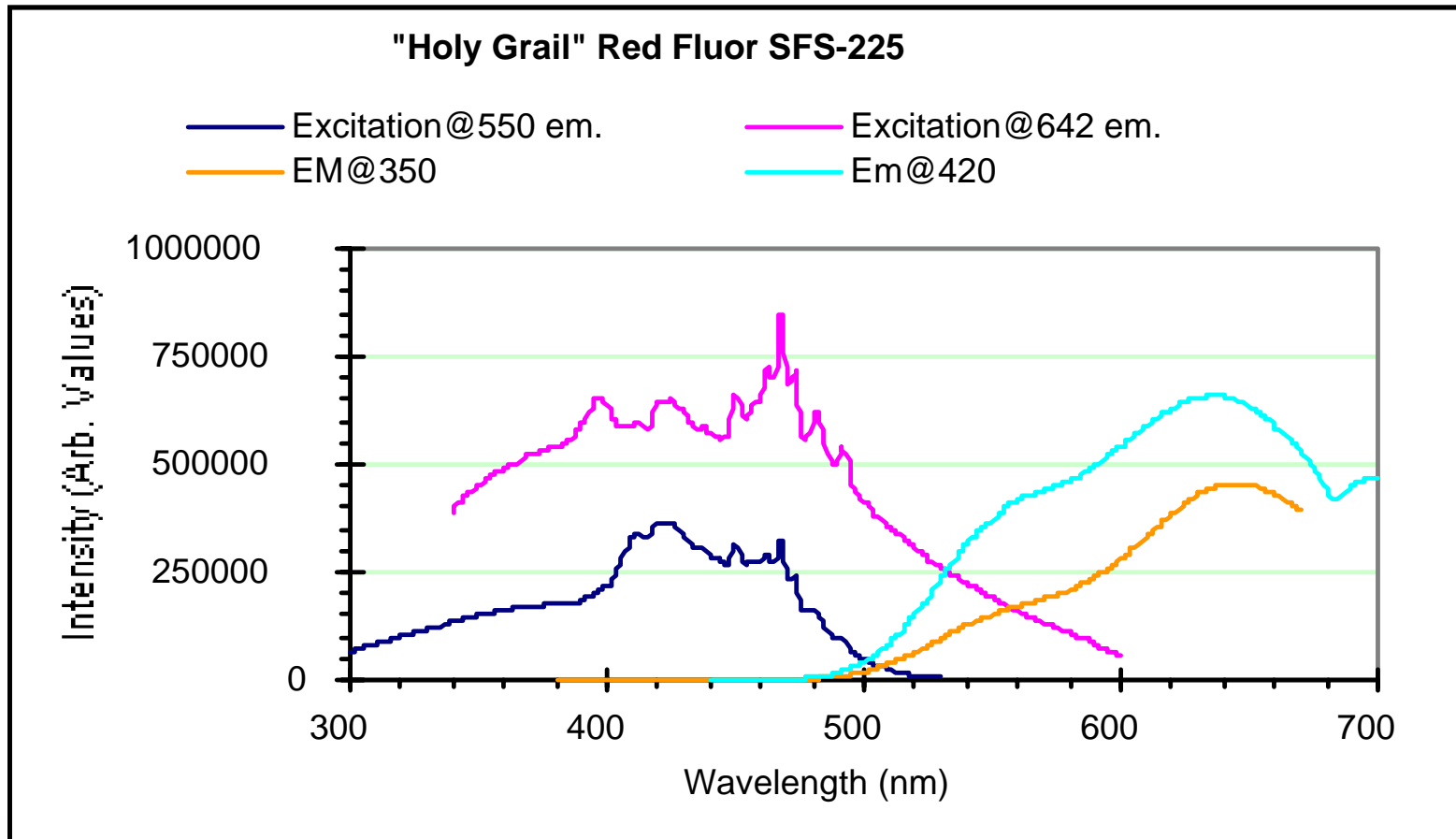


Examples of Spectralon Luminescent Standards

Orange Luminescent Pigment



Red Fluor/ UV and Visible Excitation



Please note that additional slides may be added to this presentation during the NIST Color and Appearance Symposium. In no way will the additional slides change the focus or direction of the talk.

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